DOCUMENT RESUME

ED 241 556 TM 840 065

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TITLE Concrete Operations as "Natural" Thinking.
PUB DATE 15 Oct 83
NOTE 9p.; Paper presented at the Annual Meeting of the Northern Rocky Mountain Educational Research Association (1st, Jackson, WY, October 13-15, 1983).
PUB TYPE Speeches/Conference Papers (150) -- Viewpoints (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Processes; *Developmental Stages; Elementary Secondary Education; Intuition; Logical Thinking; Neurological Organization; *Theories
IDENTIFIERS Concrete Operations; Formal Operations; *Piagetian Theory; *Proster Theory

ABSTRACT

Proster Theory is a theory of learning which has been proposed by Leslie A. Hart (1975). The theory is based on the functions of the brain. Learning is seen as the formation of programs, which are simply sequences of instructions by which the brain directs the muscles, sense organs, or other portions of the neurological system. Programs which are related are organized into structures called prosters. The theory also identifies two types of thinking: SSM (symbol selection and manipulation) thinking which is conscious and step-by-step, and PAC (perception, analysis, choice) thinking which is intuitive or "natural." There may be some relationship between the PAC/SSM distinction and the distinction of concrete operational thought from formal operational thought in Piagetian theory. This relationship and its educational implications are discussed. (BW)

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CONCRETE OPERATIONS AS "NATURAL" THINKING

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Presented to:

First Annual Meeting of the

Northern Rocky Mountain Educational Research Association

Jackson, Wyoming

October 15, 1983

CONCRETE OPERATIONS AS "NATURAL" THINKING

Proster Theory is a theory of learning which has been proposed by Leslie A. Hart (1975). The theory is based on the functions of the brain. Hart sees the process of learning as the formation of programs, which are simply sequences of instructions by which the brain directs the muscles, sense organs, or other portions of the neurological system. Programs which are related, i.e. have similar functions, are organized into program structures. Hart refers to these program structures by the neologism "proster"; hence proster theory.

Prosters are groups of programs along with a "selection device" which determines which program is put into operation. An analogy which Hart (1975) uses is that of a jukebox. Each record in the jukebox is a separate program--a sequence of instructions which results in the same sound being produced each time that program is called on. When there is input from some source (someone presses some buttons) the selection device chooses one of the programs and puts it into effect. The programs that make up a proster may range from very simple sequences to very complex. Operating a given program may lead to a link with another proster, resulting in the selection of a program from that proster. In this way prosters are linked together in a heirarchical fashion and complex behaviors may be built up.

Another important aspect of Proster Theory is the emphasis which Hart (1975) puts on the evolutionary development of the brain. Several principles of the theory which are not relevant to the discussion at hand are based on the concept of the three-part or triune brain

associated with MacLean. The topic of major concern here, also closely linked to the evolution of the brain, is thinking. Hart (1975, 1983) discusses two types or modes of thinking. One of these he calls SSM (for symbol selection and manipulation) thinking which is conscious, logical, step-by-step, or scientific thought. At the other end of the spectrum is PAC (for perception, analysis, choice) thinking. PAC thinking is described as "natural" thinking and is characterized as subconscious, subrational, or intuitive thought.

An example of SSM thinking in the extreme would be the formal logic required of a high school geometry student when proving a theorem. Every statement must be supported with a previously proven statement, the sequence of the statements and reasons are very important, and the whole thing proceeds in a very orderly manner in small steps from beginning to end. On the other hand a student in the same geometry class that looks at a drawing and says, "obviously those two angles are equal!" is using PAC thinking.

Another example of PAC or "natural" thinking is when a person is trying to solve some problem and has failed in all logical approaches, finally gives up, and later when involved in something totally unrelated, the solution "pops" into consciousness. Numerous historical examples of great ideas seem to fit this pattern from the classic case of Archimedes to the discovery of the benzene ring to the structure of DNA.

While Hart does not imply that SSM or logical thinking is necessarily "unnatural" or useless, he does argue that PAC thinking is much more powerful. One of the reasons for this difference is the fact,

according to Hart (1983), that SSM thinking must proceed in a linear one-path manner, while in PAC thinking the brain operates by simultaneously going down many paths. Hart (1983) uses an evolutionary argument to account for what he considers the much greater power and utility of "natural" thinking. He says that the structure of the human brain has remained largely unchanged for the past 250,000 years; by implication, neither the capacity nor processes of the brain have changed over that same time span. By contrast, the formal logic exemplified by SSM thinking has been developed in only the last 2500 years. For this reason, Hart maintains, the pre-logic thinking is the more natural process.

Hart (1983) also links PAC thinking with what he describes as "real world" learning. He cites, as examples, children learning to play baseball and a person learning to drive a car. In each of these cases, he says that the learning does not proceed in a step-by-step, linear, logical fashion. Rather, the learner gathers information and develops skills from rather haphazard or random input. Hart contends that this is not only the "natural" way of learning, but possibly for the specific skills involved, the only way they could be learned.

It appears that there may be some relationship between the PAC-SSM distinction and the distinction of concrete operational thought from formal operational thought associated with the developmental theory of Piaget. Concrete operational thought is often characterized as being dominated by perception and an intuitive approach to problem solving. This type of thinking has been described as lacking the logical manipulation of symbolic abstractions. On the other hand, formal operational thought is usually described as a manipulation of abstractions using

complete and proper logic. This latter type of thinking seems to be very similar to Hart's conception of SSM thinking.

One example often used to demonstrate the difference between concrete and formal operations, is the pendulum problem. In this problem, the subject is given a pendulum and asked to determine what affects the period of the pendulum's swing. The three variables involved are the length of the pendulum, the weight at the end of the pendulum, and how hard the pendulum is pushed to start the swing. To demonstrate formal operational thought, the subject must systematically hold two variables constant while manipulating only one variable. In this way the subject will very quickly solve the problem and determine that only the length will affect the rate of swing. Typically, the person who is operating at the concrete stage will not approach the problem in the same way. This person will not systematically manipulate only one variable at a time. Thus, the problem may or may not be solved in the Piagetian sense. That is, the individual may come up with the answer that only length affects period, he/she may determine that a combination of weight and length (or force and length) affect it, or may give up without reaching a conclusion. Regardless of the "solution" arrived at by the concrete operations thinker it is the lack of a "proper" logical approach to the problem that is crucial. This latter approach, being more intuitive than logical, is similar to what Hart calls "natural" thinking while the former would be SSM thinking.

Recently there has been a good deal of research and discussion centering on Piaget's assumption that virtually all individuals make the transition from concrete operations to formal operations at about

age 12. There appears to be evidence that many if not most individuals beyond this age do not function at the formal operations level. Renner, Grant, and Sutherland (1978) found that only 29% of 11th grade students and 34% of 12th grade students used a formal operations approach in a study which they conducted. In another study, Brooks, Fusco, and Grennon (1983) reported that only 19% of 18 year olds were using formal operations to solve a Piagetian task. The discussions of this lack of formal operational thought very often bring out the notion that the individuals are not necessarily incapable of formal operations, but simply do not use this approach. This would derive very easily from Hart's argument that PAC thinking (concrete operational thought) is the natural way of thinking.

According to Hart (1983) there are some educational implications arising from this PAC-SSM dichotomy (it is really not a true dichotomy, but may be better considered as a continuum). The major implication is that teachers need to show more respect for natural thinking processes on the part of their students. The present situation puts a great deal of emphasis on the logical processes associated with SSM or formal operational thought; even at age levels when Piaget's theory says the children are incapable of such. When a student is presented with a problem and comes up with a solution, the typical teacher response is, "How did you determine that answer?" If the child were to say, "It just popped into my head," this would usually not be considered an adequate response. What the teacher is usually looking for is a logical sequence of thought processes that lead to the solution. Hart argues that teachers need to strike a balance between their expectations of PAC thinking and SSM thinking.

The result of a greater tolerance and appreciation for the intuitive type of thinking may result in several benefits. It may lead to more creativity on the part of the students since creativity seems to be linked to natural thinking. It may be less frustrating for students who are not yet capable of the formal logic needed for SSM thought. And finally, even if it is thought that the formal operational thinking is superior, it may lead to a more gradual and more successful transition to this type of thinking.

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